Thoughts on Clustering Improvements

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Introduction

- Observations from
  - Previous work (2007 – 2011)
  - Current state of reconstruction (S2012.05.09)
- Main point
  - Many clustering and tracking problems can be traced back to inadequate hit reconstruction
- Examples in this talk
  - Hit fit range impact on resolution and close hit separation
  - Hit width vs track dip angle
  - Hit charge

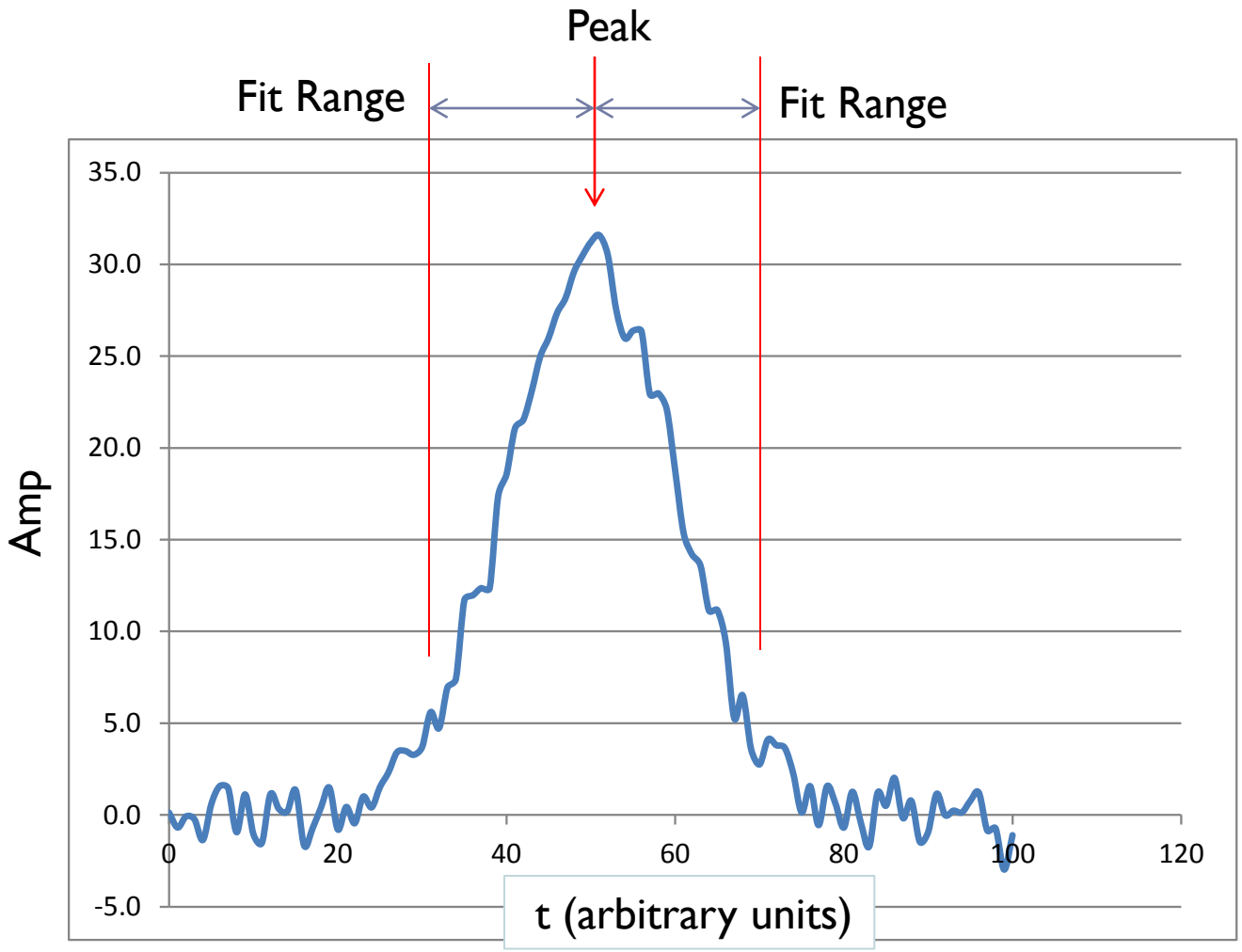
Hit Fitting

- What is the optimum way to fit the shape of a hit to achieve the best position resolution?
  - Factors – S/N, range of the Gaussian fit
  - Is it best to fit as many time bins as possible in the signal region?
- Method – Use Excel to simulate the hit resolution study (May 18, 2011 LArSoft meeting)

Details

- Create 100 time bins
- Generate a true signal using Excel normal distribution function
  - Variable amplitude, σ and peak time (time bin = 50)
- Generate noise to apply to each time bin using a normal distribution
  - Variable noise rms
- Add signal to noise in each time bin
- Define a variable "fit" range → next slide

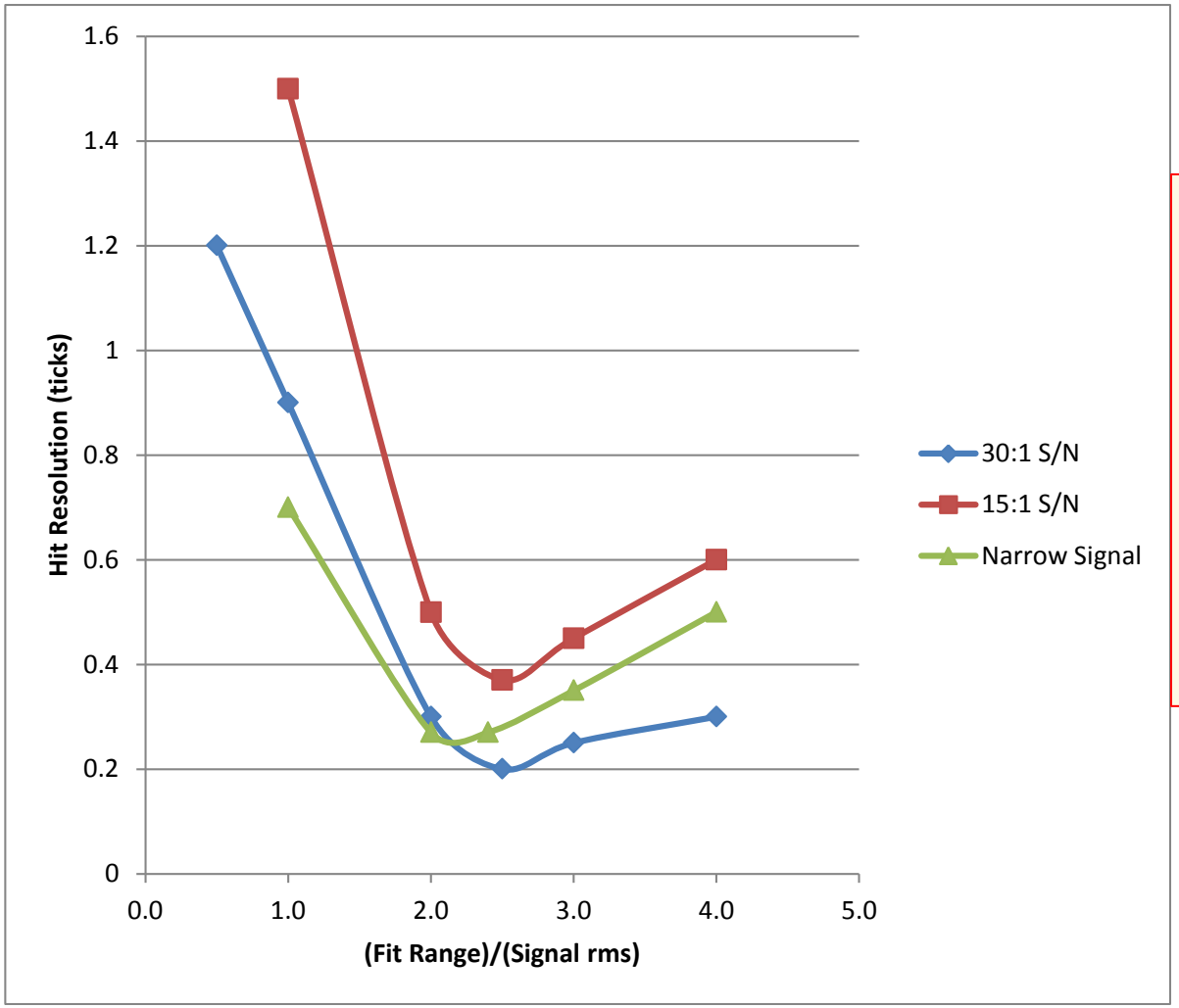
“Fit” Range



Hit position =

$$\frac{\Sigma\,\mathrm{ADC} \times t}{\Sigma\,\mathrm{ADC}}$$

“Hit Resolution” vs Fit Range

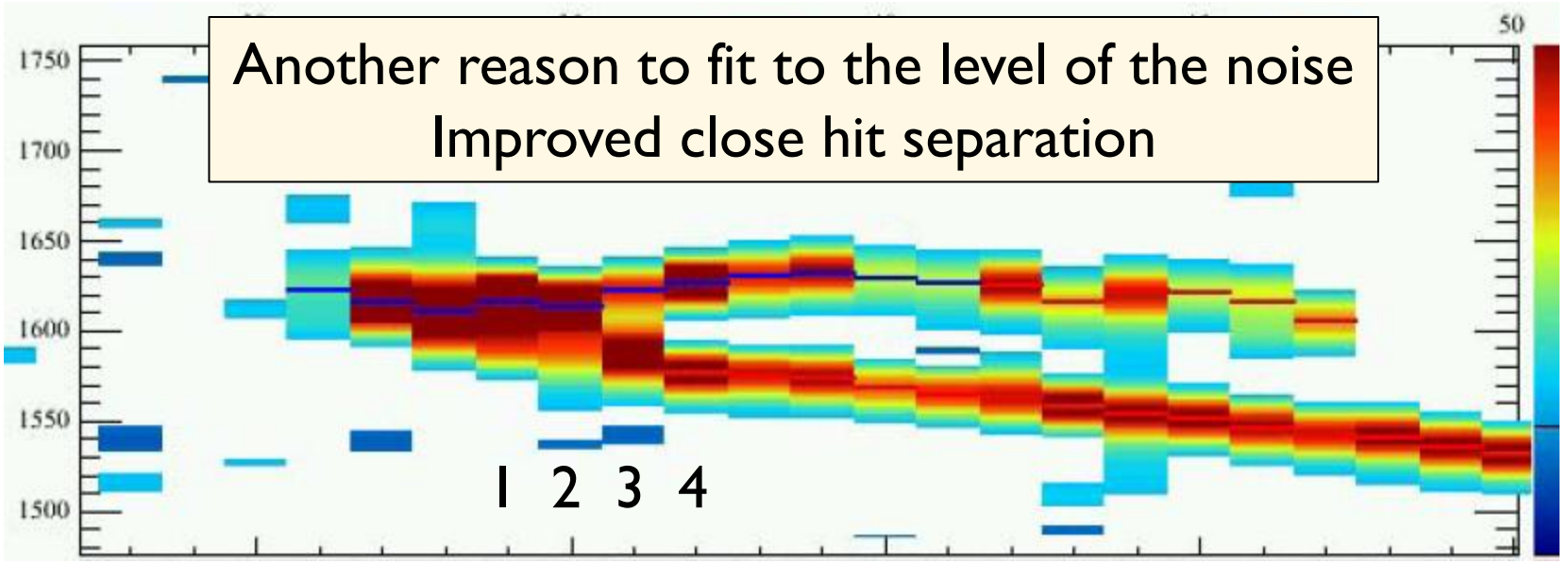


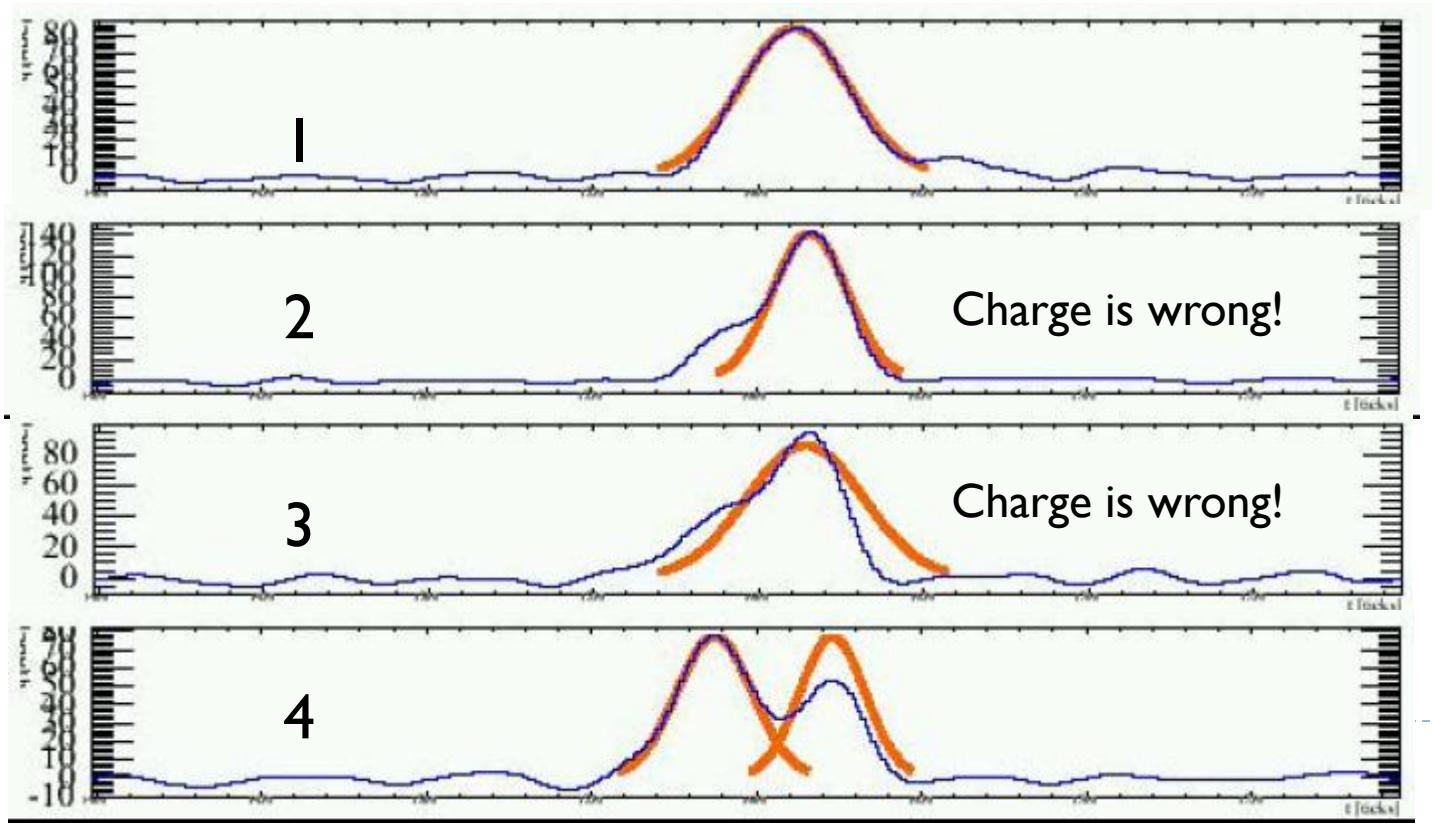
Conclusion

Get the best hit position resolution by fitting the range > ~1.5 x noise rms.

Currently FFT and Gaus hit finders fit to the range > ½ peak

Another reason to fit to the level of the noise
Improved close hit separation



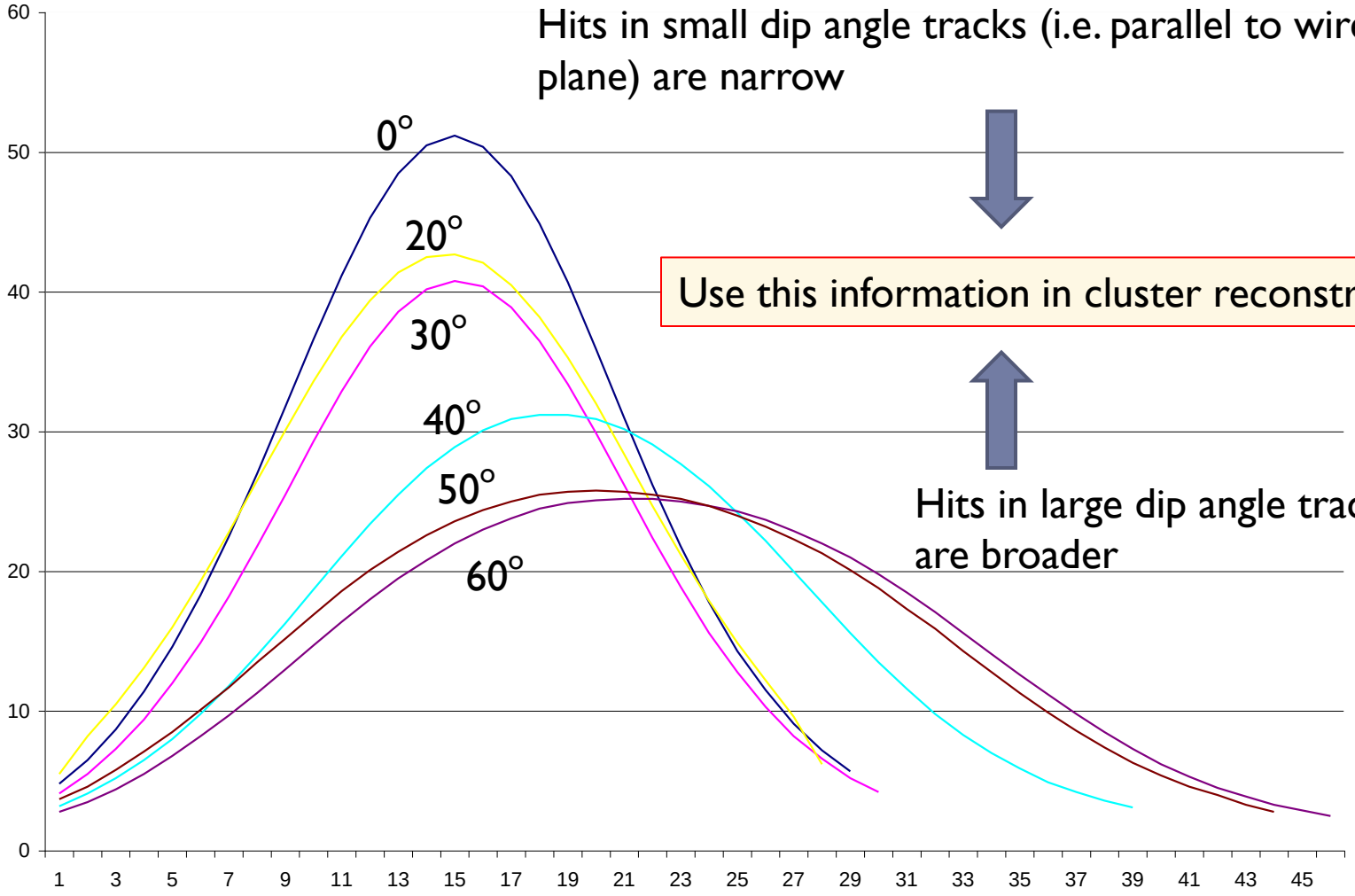


1) Fit to noise level
2) Split hit if χ^2 too high

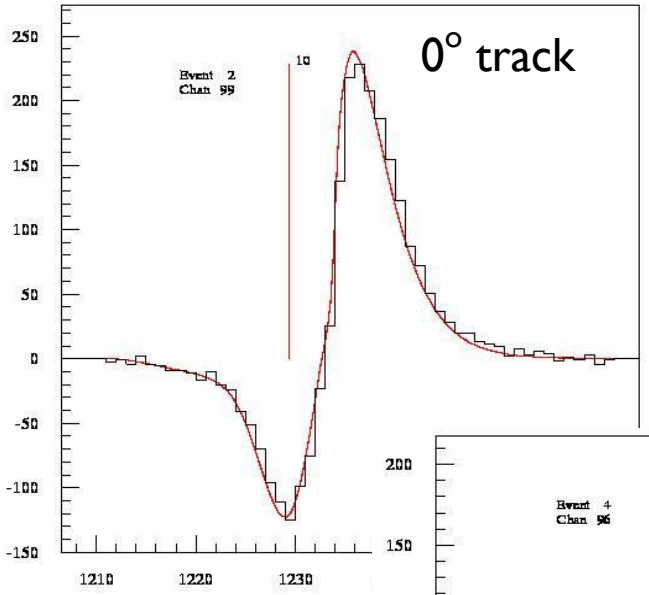
Note: using ancient version S2012.05.09

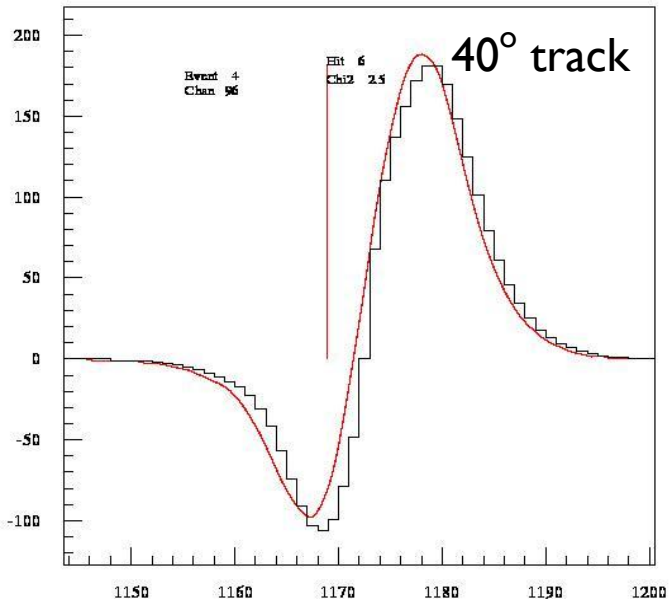
Collection Plane Hit Shape Templates

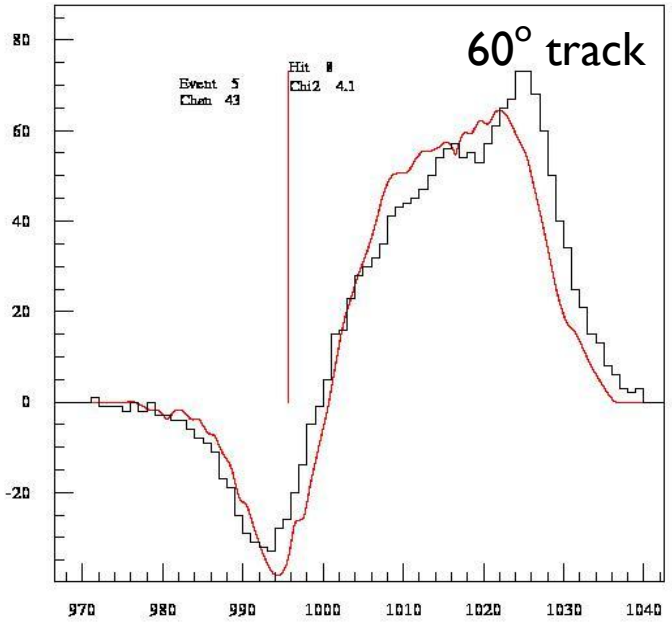
If hits are not Gaussian in shape



Induction Plane Hit Shape Templates







Old MC Study (Pre-ArgoNeuT Running)

- Used hit shape templates for different angle tracks (0°, 20°, 40°, 60°)
- This study predates the use of deconvolution
- Reconstruct hits on MC tracks at various angles
  - Fit to each shape template – 2 parameters (amplitude, time)

True track angle

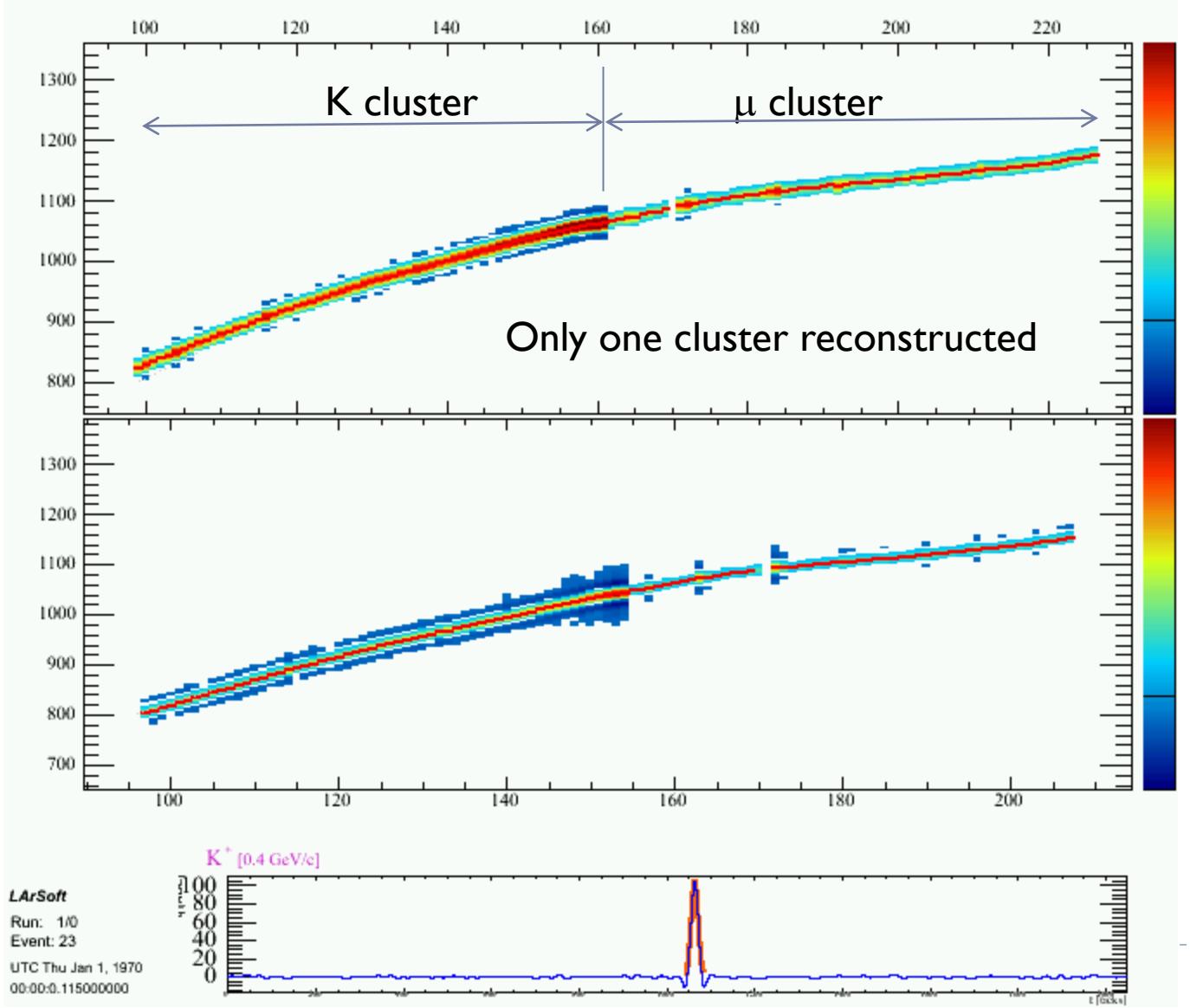
Reco Shape Flag ~ Track Angle/10

	1	2	3	4	5	6	10
10	76%	14%					10%
20	40%	43%		2%			15%
30	10%	46%		27%			17%
40	6%	18%		52%		1%	23%
50	3%	5%		14%		8%	70%
60		6%		11%	2%	11%	70%
70						21%	79%
80							100%

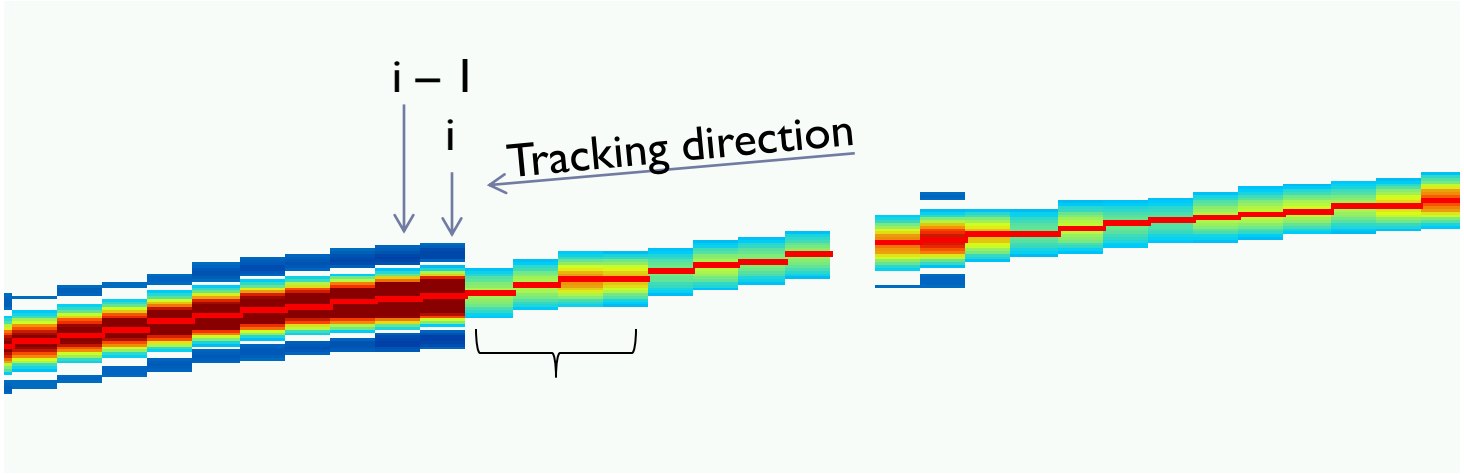
No template

In principle, a scheme like this should work with GausHitFinder using the hit start time and end time

Using Hit Charge to guide Reconstruction Example MC K → μ decay



Local Tracking Algorithm



- Find average hit charge <Q> and average hit width <σ> using the last 4 hits on the cluster
- Skip the hit if Q or σ of the hit on the next wire (i) is much different than <Q> or <σ>
- Stop tracking if this condition is also met on wire i – 1

Conclusions & Plans

- Full use of hit information will improve tracking
- This will be particularly important for DIS events and for hits near the vertex
- I propose to start working on hit reconstruction and simulation
  - Is there a need to deconvolute the MicroBooNE collection plane signals?
  - Study of hits in Bo and Long-Bo cosmic ray data would be a good starting point – same electronics as MicroBooNE